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REPORT NO. FGT-2186 Date: 10 Sept. 1962

MATERIAL - GLASS CLOTH REINFORCED PLASTICS -ROOM AND ELEVATED TEMPERATURE - PROPERTIES OF

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A DIVISION OF GENERAL DYNAMICS CORPORATION (FORT WORTH)

TEST F-6072

MODEL B-58

FINAL

REPORT FGT-2186

TITLE
MATERIAL - GLASS CLOTH REINFORCED PLASTICS

ROOM & ELEVATED TEMPERATURE - PROFERTIES OF

SUBMITTED UNDER

AF33(600)-36200

PREPARED BY: S. V. Glorioso	GROUP: METALLURIGICAL Engineering Test Laboratories
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(FORT WORTH)

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REPORT NO FGT-2186

MODEL B-58

DATE 7-26-60

MATERIAL - GLASS CLOTH REINFORCED PLASTICS

ROOM & ELEVATED TEMPERATURE - PROPERTIES OF

PURPOSE:

The purpose of this investigation was to establish design allowables for glass-cloth reinforced plastic panels with the following fabric and resin combinations:

181 Cloth with Class II (Laminac 4232) resin 181 Cloth with Class III (Conolon 506) resin 181 Cloth with Class IV (Epon 828) resin 143 Cloth with Class II (Laminac 4232) resin 143 Cloth with Class III (Conolon 506) resin 143 Cloth with Class IV (Epon 828) resin 120 Cloth with Class IV (Epon 828) resin 120 Cloth with Class III (Conolon 506) resin 120 Cloth with Class III (Conolon 506) resin 120 Cloth with Class IV (Epon 828) resin 183 Cloth with Class II (Laminac 4232) resin 183 Cloth with Class III (Conolon 506) resin 183 Cloth with Class III (Conolon 506) resin 183 Cloth with Class IV (Epon 828) resin

In Part I of FGT-2186, the fabrication history and material source is included with the physical and mechanical properties of each panel. Compression testing was not completed at the time of publication of Part I. This report presents the results of the compression tests which complete this investigation.

SUMMARY:

Compression properties on 12 different cloth-resin combinations were obtained. Testing was done at R.T., 300 and 500 F. Properties were obtained at angles of 0, 45, and 90° to warp direction. The effect of soaking in boiling water on the RT compression properties was also determined.

From each compression specimen the ultimate compressive strength and compressive modulus was determined and recorded. Laminates made with 181 cloth had values for compressive strength in the warp direction which were approximately equal to these properties when tested 90° to the warp direction. The properties at 45° to the warp direction however, were reduced by approximately 50%.

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Specimens of 181 cloth with Class II (4232) resin retained slightly less than 50% of their room temperature compressive strengths at 500 F. Average compressive strength values of specimens of 181 cloth with Class III (506) resin show that this material retained approximately 60 to 70% (depending on the specimen direction) of its room temperature compressive strength, at 500 F. Specimens of 181 cloth with Class IV (828) resin retained less than 50% of their room temperature strength at 300 F. The compressive strength of this material was below 5 ksi at 500 F, a decrease of over 90% of the room temperature value at 0 and 900 to the warp direction.

For laminates made with 143 type cloth the average values of compressive strength at 45 and 900 to the warp direction were approximately equal. These values are less than 45% of the values obtained parallel to the warp direction.

The following treatments had no effect on the compressive properties at 300 F for the materials listed:

Materials

resin

181 Cloth with Class II (4232) 181 Cloth with Class III (506) 143 Cloth with Class II (4232)

181 Cloth with Class IV (828) resin

Treatment

Soaked at 300 F for 100 hrs. while stressed to 20 or 40% of their room temperature compressive strengths.

Soaked at 300 F for 100 hrs. while stressed to 20% of its 300 F compressive strength.

As part of this investigation an evaluation of compression test procedures for fiberglass was made. Four test set-ups were evaluated and appeared to have about the same accuracy. The Federal Specification LP-406B compression jig using a Baldwin PC7M compressometer was the least dependent on operator technique. For this reason it was considered superior to other methods at temperatures up to 300 F, which is the operating limit of its strain measuring system. The Convair-built leaf type compression jig was used satisfactorily for the 500 F tests.

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MATERIAL - GLASS CLOTH REINFORCED PLASTICS ROOM & ELEVATED TEMPERATURE - PROPERTIES OF

OBJECT:

- 1. To determine the compression properties at room and elevated temperatures for various glass fabric and resin combinations of plastic laminated materials. The following combinations were tested: 120 cloth, 143 cloth, 181 cloth, and 183 cloth with Class II (Laminac 4232), Class III (Conolon 506), and Class IV (Epon 828) resins, as specified in FMS-0031(A), at 0, 45, and 90° to the direction of warp of the material.
- 2. To evaluate the different test procedures for obtaining compression properties.

PROCEDURE:

Sixty glass reinforced plastic panels, numbered 101 through 160, of the following glass fabric and resin combinations were fabricated at Convair, Fort Worth:

Panel Number	Glass Fabric	Resin as Specified In FMS-0031A	Panel Size (In.)
101-105	181 Cloth	Class II (4232)	26 x 24
106-110	181 Cloth	Class III (506)	26 x 24
111-115	181 Cloth	Class IV (828)	26 x 24
116-120	143 Cloth	Class II (4232)	24 x 22
121-125	143 Cloth	Class III (506)	24 x 22
126-130	143 Cloth	Class IV (828)	24 x 22
131-135	120 Cloth	Class II (4232)	14 x 12
136-140	120 Cloth	Class III (506)	14 x 12
141-145	120 Cloth	Class IV (828)	14 x 12
146-150	183 Cloth	Class II (4232)	14 x 12
151-155	183 Cloth	Class III (506)	14 x 12
156-160	183 Cloth	Class IV (828)	14 x 12

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A fabrication history, a list of vendors who supplied the materials, and various physical and mechanical properties for each panel are included in Part I of this report.

Compression properties were determined for each condition shown in Table I. Four specimens, one from each of four panels of each fabric and resin combination were tested in the conditions indicated. To retain identity, each specimen was marked with the panel number from which it was taken and the letter A, B, or C, depending on the directionality with relation to the warp. The letter A signifying that it was parallel to the warp, B, that it was 45° to the warp direction and C, that it was 90° to the warp direction.

Since there were no standardized test procedure for obtaining compression properties of plastic laminates, several fixture arrangements were used in the course of the testing to evaluate the different procedures. The following fixtures were used:

- 1. Convair-built spring leaf support type (Figure 1). This jig was used for 26% of the testing including all tests at 500 F.
- 2. Federal Specification LP-406B jig with Baldwin B-3M extensometer, (Figure 2A). This was used for 51% of the tests.
- 3. Federal Specification LP-406B jig with Baldwin PC-7M compressometer, (Figure 2B), used for 21% of the tests.
- 4. Federal Specification LP-406B jig with extension arms extending out of the test oven (Figure 3) to a microformer extensometer. An evaluation of this fixture was published in FGT-1735. In this investigation it was used at room temperature for 3% of the tests.

A comparison of the performance of the four test fixtures was made on 2024-T86 aluminum specimens at room temperature.

In the Convair built leaf type jig, the specimen is supported by leaves which can deflect. Figure 1 shows the leaves in the open position for reloading. A thermocouple extends through the leaves and touches the center of the specimen. Strain is measured over a 1" gage length on the centerline of the supported faces of the specimen. The strain from the faces is averaged and autographically recorded.

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The following procedure was used for testing with the LP-406B jig. The screws which fastened the supporting plates were hand tightened. The top compression head was rigidly attached to the test machine. The bottom compression head rested on three threaded studs which were adjusted so that the specimen was loaded uniformly at the ends. A thermocouple was attached to the side of the specimen along the reduced section.

Specimens were machined to the dimensions shown in Figure 4. All specimens were loaded at a constant rate such that failure occurred in approximately 2 to 3 minutes. Tests were conducted on 60,000 and 5,000 lb. capacity Baldwin universal test machines. Compression load vs. strain curves were recorded autographically. Heating for elevated temperature tests was accomplished with circulating air ovens.

In order to determine the effect of exposure for 100 hours at 300 F under sustained compressive stress, specimens were loaded in Riehle creep-rupture machines using the jig shown in Figure 5. The bolts holding the support plates on the sides of the specimen were hand-tightened. The loading was at 20 or 40% of the average compressive strength at room temperature. After loading for 100 hours, each specimen was removed and tested in compression at 300 F. An exception to this procedure was used for specimens taken from panels fabricated using 181 cloth with Class IV (828) resin. Because the compressive strength of this material at 300 F is less than 45% of the room temperature compressive strength, the loads were 20% of the average compressive strength at 300 F.

RESULTS:

The compression properties for each specimen are given in Tables II through IX, and are shown graphically in Figures 6 through 12. Typical compression stress-strain curves for each condition are shown in Figures 13 through 28.

DISCUSSION:

The compressive moduli for two of the laminates at elevated temperature could not be determined from the load-strain curves because the materials deformed inelastically at very low stresses. This low elasticity and strength were exhibited by the 181 and 143 cloth laminates bonded with 828 resin. The stress-strain

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curves for these materials at some elevated temperature test conditions could only be represented as shaded areas as shown in Figures 20 and 26.

Compression failures occurred in one of three ways - crushing or buckling the material along the reduced section of the specimen, crushing either end of the specimen, or by delaminating. Delamination failures are those in which the bonds between the layers of cloth were broken and the layers separated. End failures occurred because the ends of specimens were somewhat weakened from the machining operation. The compressive strength tabulated for specimens on which end failures occurred was obtained by dividing the maximum load by the minimum cross sectional area of the specimen. Such values are not included in the averages in Tables II through IX and are lower than the compressive strength for the specimen. The location of failure is included for each specimen in the data sheets.

For laminates made with 181 cloth (see Figures 6, 7, and 8) the average values for compressive strength and modulus measured parallel to the warp direction were approximately equal to these properties when measured 90° to the warp direction. The average values measured 45° to the warp direction were approximately half the parallel and 90° values.

Specimens made of 181 cloth with Class II (4232) resin retained slightly less than 50% of their room temperature compressive strengths at 500 F in each of the three directions tested. The average compressive strength values of specimens made of 181 cloth with Class III (506) resin and tested at 500 F show that this material retained 60 to 70% of its room temperature strength at 500 F, depending on the specimen direction. The compressive strength of 181 cloth with Class IV (828) resin was less than 50% of its room temperature value at 300 F and below 5 ksi at 500F. This represented a decrease of over 90% of the room temperature values in the 0 and 90° to the warp direction. The elevated temperature compressive properties of 181 cloth laminates were not affected by stressing and soaking for 100 hours at 300 F.

Laminates made using 143 cloth had average values for compressive strength at 45 and 90° to the warp direction which were approximately equal. Values for these directions at room temperature were 30 to 45% (depending on the resin) of the average compressive

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strengths obtained parallel to the warp direction. No significant effect on the 300 F properties was observed on specimens of 143 cloth with Class II (4232) resin due to loads at 300 F of 20 or 40% of the room temperature strength for 100 hours. (See Table V).

Testing experience with the four test set-ups established the LP-406B fixture with the Baldwin PC-7M compressometer (Fixture 3) as the preferable one for temperatures up to 300 F. The Convair leaf type jig was satisfactory at higher temperatures.

The accuracy of the fixtures was not rigorously determined in this investigation, but was nominally the same for all the fixtures when checked on .125" thick 2024-T86 aluminum specimens. The accuracy obtained with jig No. 2 which employed a non-averaging extensometer, was greatly affected by any lack of parallelism of the specimen ends.

The No. 3 fixture was found to be the least dependent on operator technique in attaching the strain measuring system to the specimen. Because of this, the No. 3 fixture permits testing to proceed faster than with other jigs and with the least chance for operator error. Its use is limited to a miximum temperature of 300 F, which is the operating limit for the PC-7M compressometer.

CONCLUCIONS:

The results of this investigation consist of empirical data to be used in establishing design allowables at room and elevated temperatures for all combinations of the following fabrics and resins; types 181, 143, 120, and 183 cloths with Class II (Laminac 4232), Class III (Conolon 506) and Class IV (Epon 828) resins. From the data obtained the following general conclusions are drawn:

- 1. Laminates made using 181 cloth had compression strengths parallel to and at 90 degrees to the warp direction which were approximately twice the strength of the material at 45° to the warp direction.
- 2. Laminates made using 143 cloth had compression strengths which were approximately equal at 45 and 90° to the warp direction. These properties were 55 to 70% (depending on the resin used) less than the strength parallel to the warp direction.

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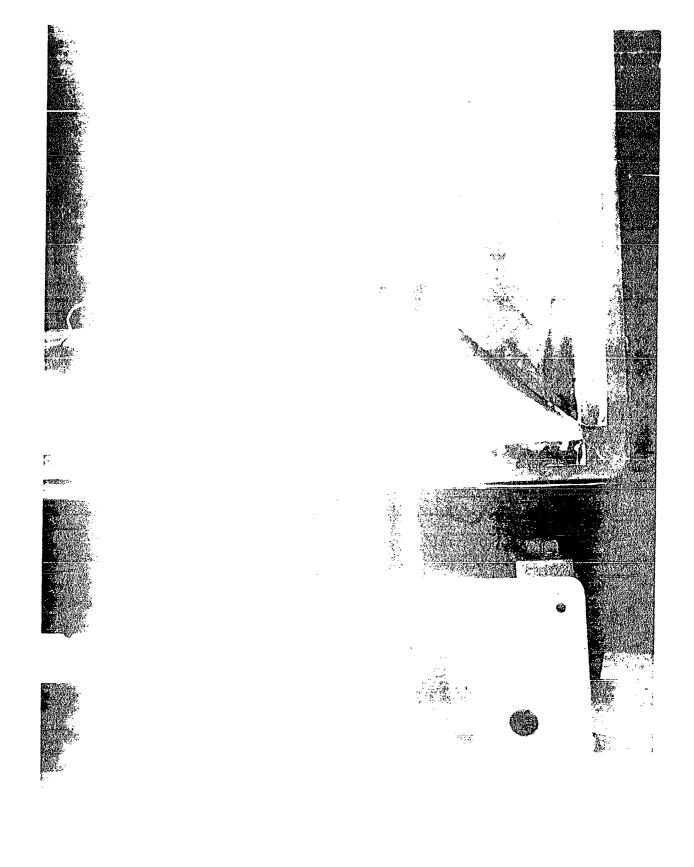
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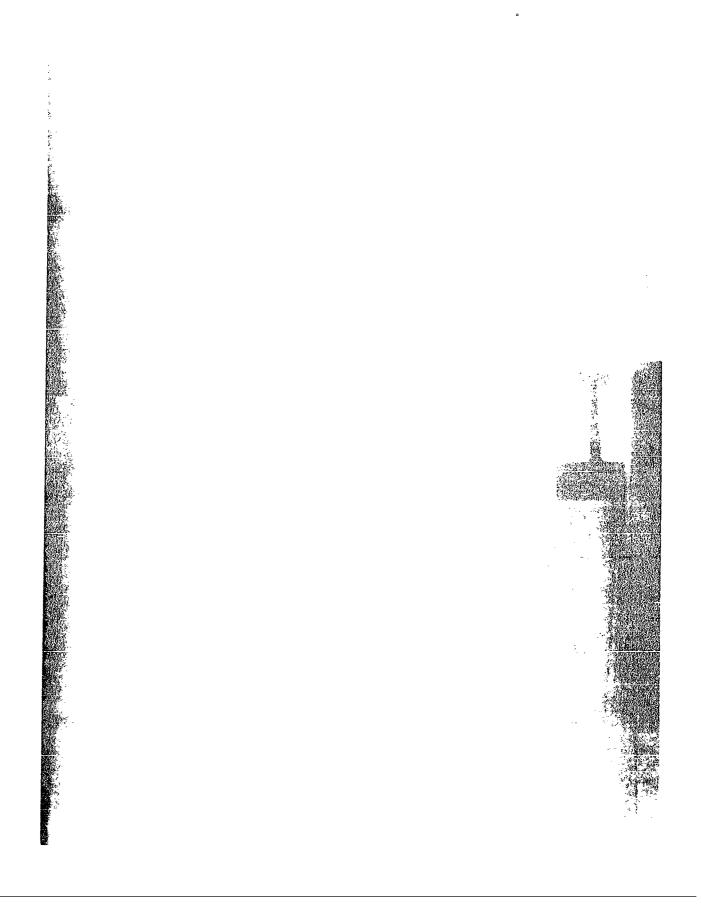
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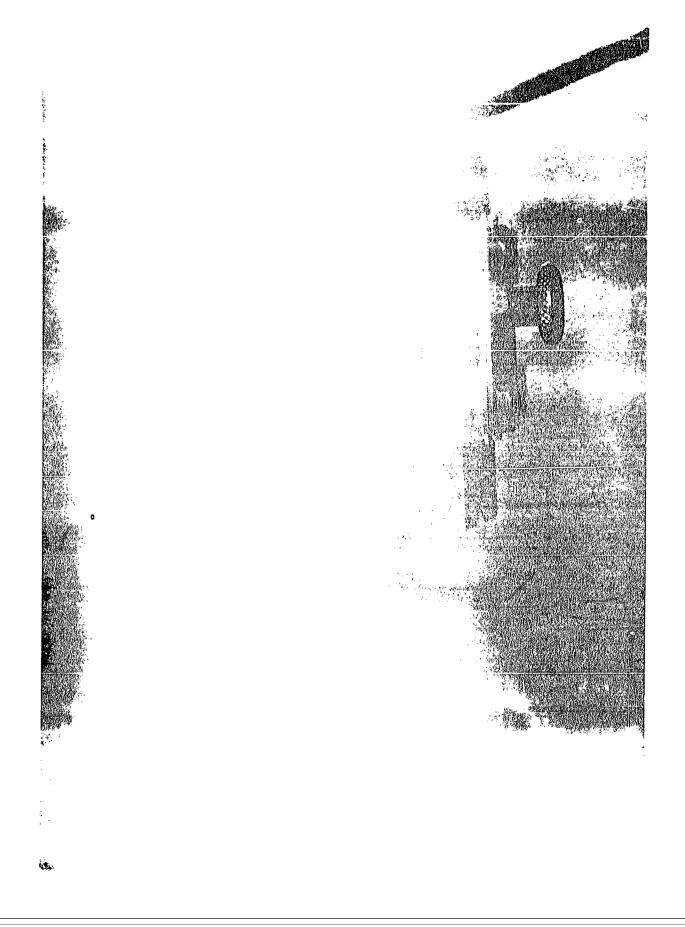
- 3. Exposures for 100 hours at 300 F at loads of 20 or 40% of the room temperature compressive strength had no effect on the compressive properties at 300 F parallel to the warp direction for the following cloth and resin combinations: 181 cloth with Class II (4232) resin, 181 cloth with Class III (506) resin, and 143 cloth with Class II (4232) resin. Similar exposures at loads of 20% of the 300F compressive strength had no effect on the compressive properties at 300 F for 181 cloth with Class IV (828) resin.
- 4. The Federal Specification LP-406B jig with a Baldwin model PC-7M compressometer was the easiest and fastest combination to use for tests up to and including 300F. The Convair built leaf type compression jig was satisfactory for 500 F tests.

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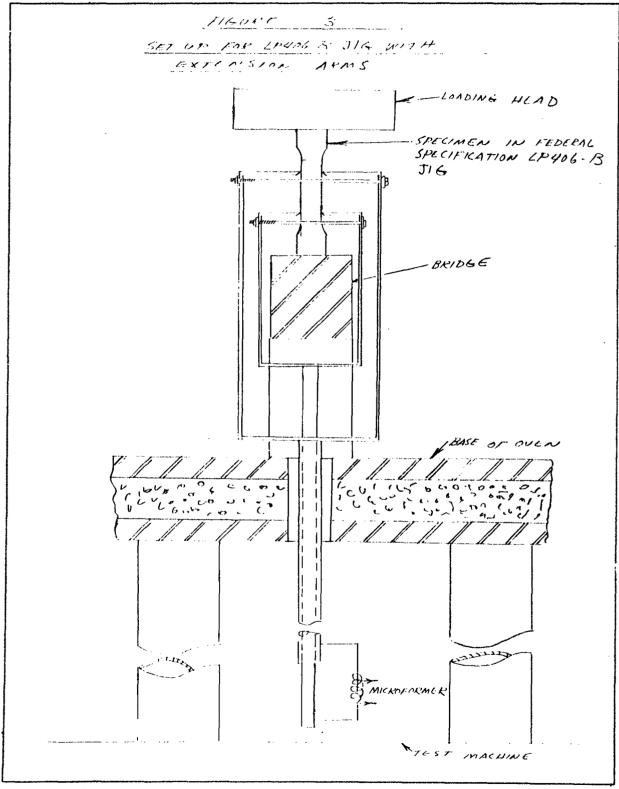






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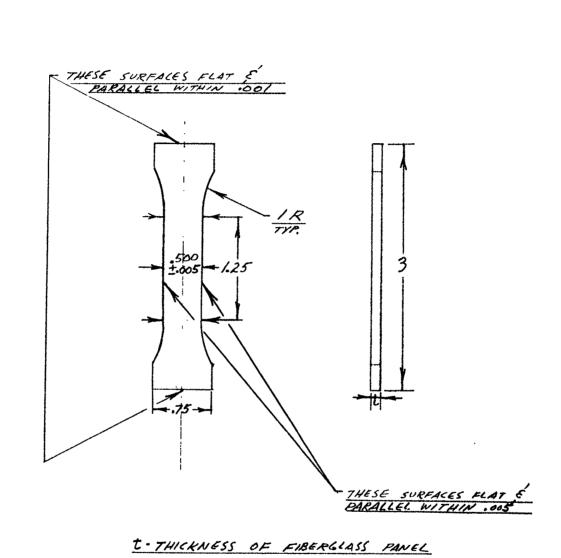
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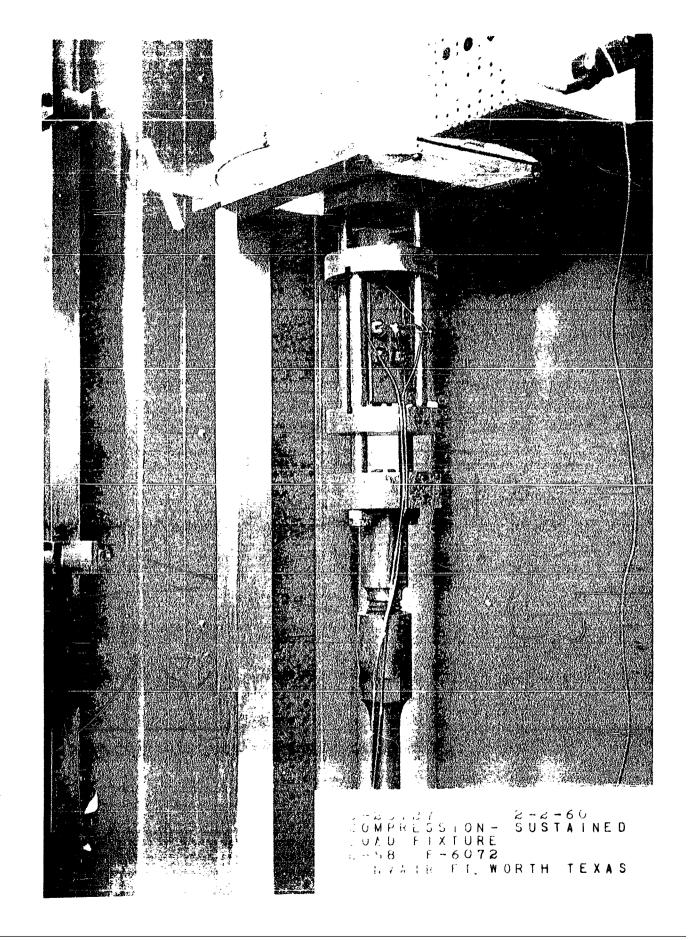
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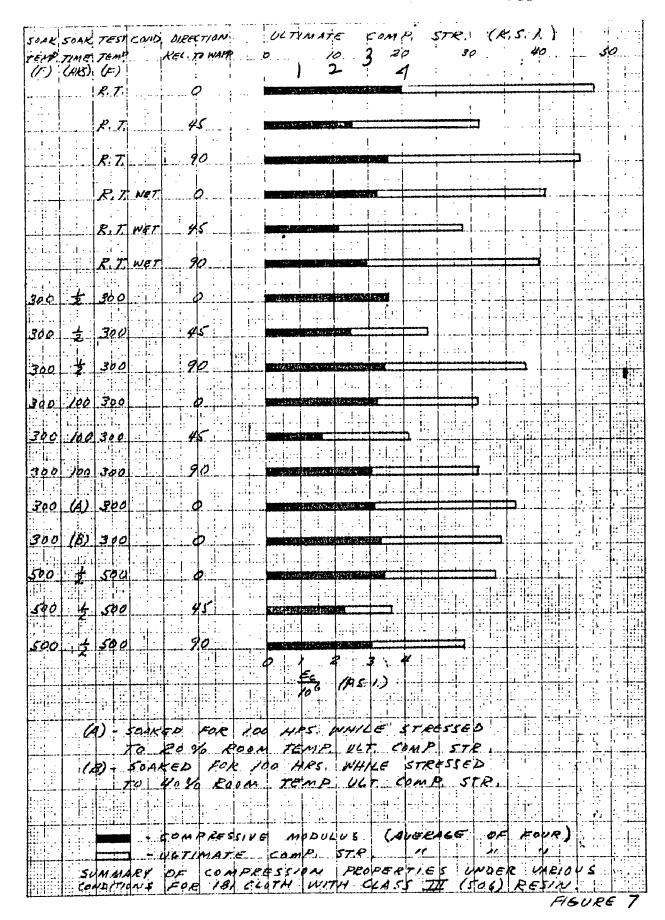


COMPRESSION SPECIMEN

FIGURE 4



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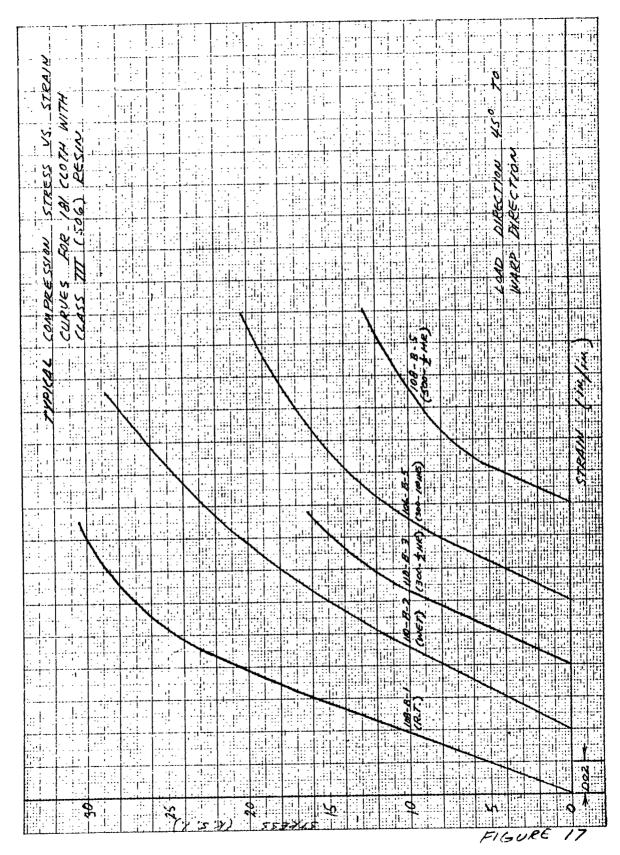
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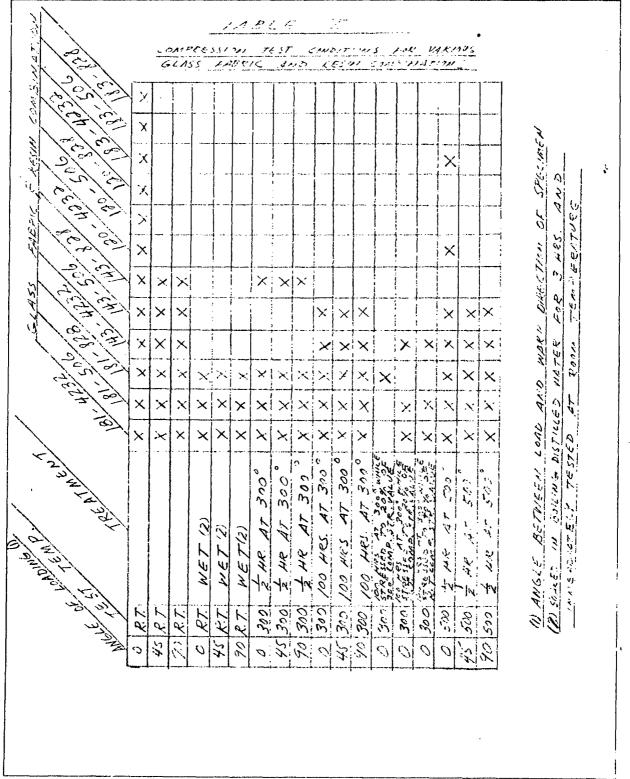
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10 STEAM MEASUREMENT. CONVAIR BUILT LEAF TYPE LP406-B WITH B-3M EXTENSOMETER LP406-B WITH PC-7M COMPRESSOMETER LP406-B WITH CONVAIR BUILT EXTENSION ARMS. SETWEEN LOAD AND WARP DIRECTION OF SPECIMEN SED IN BRITISH DISTULCED WATER TWEN AND MINERIATELY TESTED AT PAIN TRANSPAT THATE COMP, STR. VALUE NOT INCLUDED IN ALERAGE	105-4-3						32.3	3.95	"	*	8		 	
S 4ND STRAIN MEASUREMENT. 1 - CONVAIR BUILT LEAF TYPE 2 - LP406-B WITH B-3M EXTENSOMETER 3 - LP406-B WITH CONVAIR BUILT EXTENSION ARMS. 4 - LP406-B WITH CONVAIR BUILT EXTENSION ARMS. ANGLE BETWEEN LOAD AND WARP DIRECTION OF SPECIMEN SOAKED IN BOUNKS DISTULED WARP LUE NOT INCLUDED IN AUERAGE.	AVERAGE						29.7	2.82						
S AND STEAM MEASUREMENT. 1 - CONUANE BUILT LEAF TYPE 2 - LPYPE-B WITH B-34 EXTENSOMETER 3 - LPYPE-B WITH PC-7M COMPRESSOMETER 4 - LPYPE-B WITH CONUANE BUILT EXTENSION ARMS. 4 - LPYPE-B WITH CONUANE BUILT EXTENSION ARMS. 4 - LPYPE-B WITH CONUANE BUILT EXTENSION ARMS. 4 - LPYPE-B WITH CONUANE BUILT EXTENSION ARMS. 4 - LPYPE-B WITH CONUANE BUILT EXTENSION ARMS.														
S AND STRAIN MEASUREMENT, 1 - CONVAIR BUILT LEAF TYPE 2 - LPHOG-B WITH B-3M EXTENSOMETER 3 - LPHOG-B WITH PC-7M COMPRESSOMETER 4 - LPHOG-B WITH CONVAIR BUILT EXTENSION ARMS. 4 - LPHOG-B WITH CONVAIR BUILT EXTENSION ARMS. 4 - LPHOG-B WITH CONVAIR BUILT EXTENSION ARMS. 4 - LPHOG-B WITH CONVAIR BUILT EXTENSION ARMS. 4 - LPHOG-B WITH CONVAIR BUILT EXTENSION ARMS. 4 - LPHOG-B WITH CONVAIR BUILT EXTENSION ARMS. 4 - LPHOG-B WITH CONVAIR BUILT EXTENSION ARMS. 5 - LPHOG-B WITH CONVAIR BUILT EXTENSION ARMS.													 	
1 - CONVANE BUILT LEAF TYPE 2 - LP466-B WITH B-3M EXTENSOMETER 3 - LP466-B WITH PC-7M COMPRESSOMETER 4 - LP466-B WITH CONVAIR BUILT EXTENSION ARMS. - ANGLE BETWEEN LOAD AND WARP DIRECTION OF SPECIMEN - SOAKED IN BOILING DISTULED WATCH THE AND MIMERIATELY TESTED AT PAIN TAMPENATE. - OLTIMATE COMP, STR. VALUE NOT INCLUED IN AVERAGE	2 4 2	STRAIN		KUREM	627.									
2- LP466-B WITH B-3M EXTENSOMETER 3- LP466-B WITH PC-7M COMPRESSOMETER 4- LP466-B WITH CONNAIR BUILT EXTENSION ARMS. - AUGLE BETWEEN COAD AND WARP DIRECTION OF SPECIMEN - SOAKED IN BOILING DISTULED WATCH THE AND MANERALE TESTED AT ROW THREED IN AVERAGE			8012 T	450 JE	7									
3- LP406-B WITH CONVAIR BUILT EXTENSION ARMS. 4- LP406-B WITH CONVAIR BUILT EXTENSION ARMS. - AUGLE BETWEEN LOAD AND WARP DIRECTION OF SPECIMEN - SOAKED IN BOILING DISTULED WATER TOP 3 HES, AND MANERAL TESTED AT PAIN TEMPERATE. - OLTIMATE COMP, STR. VALUE NOT INCLUDED IN AVERAGE	,	8-904	WITH	8-3,	2	renson	# € T € €							F
4-LP406-B WITH CONVAIR BUILT EXTENSION ARMS. - MIGLE BETWEEN LOAD AND WARP DIRECTION OF SPECIMEN - SOAKED IN BOWING DISTULED WATER TOP 3 HES, AND IMMEDIATELY TESTED AT POUR TEMPERATE. - ULTIMATE COMP, STR. VALUE NOT INCLUDED IN AVERAGE		8-90%	WITH	DC-	7111	8	10	METE	0				 	rg?
- AWELE BETWEEN LOAD AND WARP DIRECTION OF SPECIMEN - SOAKED IN BOILING DISTILLED WITTER TOWN TAMERAT TESTED AT ROOM TAMERAT - OLTIMATE COMP. STR. VALUE NOT INCLUDED IN AVERAGE	ı	ı	WITH	CONI	416	•	SXTE	VSION	ARMS				_	7-2
- AUGLE BETWEEN LOAD AND WARP DIPECTION OF SPECIMEN - SOAKED IN BOILING DISTULED WITTER TOP 3 HES, AND MIMERIATELY TESTED AT FOUN TEMPERATE														218
- ANGLE BETWEEN LOAD AND WARP DIRECTION OF SPECIMEN - SOAKED IN BOILING DISTILLED WATER TOP 3 HES, AND IMMEDIATELY TESTED AT PAIN - ULTIMATE COMP, STR. VALUE NOT INCLUDED IN AVERAGE														36
- AUGLE BETWEEN LOAD AND WARP DIRECTION OF SPECIMEN - SOAKED IN BOILING DISTILLED WATER THE AND MIMENATELY TESTED AT FORM - OLTIMATE COMP. STR. VALUE NOT INCLUDED IN AVERAGE												-		
- SOAKED IN BOILING DISTULED WATER TOR 3 HPS. AND MINEDIATELY TESTED AT POINT - ULTIMATE COMP, STR. VALUE NOT INKLUDED IN AVERAGE		BETWEEN			Ш	DIRECT			ECIME	2				
- ULTIMATE COMP. STR. VALUE NOT INCLUDED IN ALERAGE				93771	3.34716	did	3 445	AND)	NATELY	TESTED	74	, ,	CATUR
	1		JWC	STR	VALUE	101	ž	DED.	3	VERA			ļ.	

TABLE I CONTO. COMPRESSION TESTS

Page 40 FGT-2186 MENSURENIT 5784 ٩ ₹ ₹ 4444 4486 all ex 68 ex 716 18 18 4 4 4 4 6 4 シングラク 1.07 DELAMINATION IN SECTIVI SECTINA SECTION SECTION SECTION 1 : 1 ٠ 1 1 ٠ ? . ٠ (4232) 2.37 REDUCED 1.01 REDUCED · 67 DELAMINA REDIKED PEDUCED. REDUKED 1000 : • ; • 1 : • • 2.64 2.76 2.92 1.04 2.44 2.40 4.88 2.27 1.12 2.59 2.57 2.54 2.61 Ŕ Ec. Ŋ 29.0 28.5 29.0 28.9 28.4 26.95 30.1 19.0 34.7 36.9 3/.3 13.5 0 7 35.1 17.6 29. V. ó, ó. 300E ý 4 517. 1 SOAKED (2)1167 FOR 0 V ď 300 か、アン TEST TEMP. 1) ANGEL E DEGREES) 45 06 TABULATION SHEET 06 0 101-13-3 102-13-3 103-16-3 101-6-3 3 102-6-3 105-6-3 10 103-4-4 103-C-2 105-C-2 4-4-50 4VERAGE 102-4-4 4VERAGE 100-8-5 101-8-12 103-8-2 AVERAGE NERAGE 102-8-2 4-4-101 103-6-4VERAGE 102-5-2 100-18-2-2-10 SPECINEN

CONVAIR—FORT WORTH
TABULATION SHEET

TABLE II CONTO. COMPRESSOM TESTS

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TABLE III COMPRESSION TESTS

Page 43 FGT-2186 TAME CATIPE MEAK JAMES WOY 410 STEAN 78 Ŋ 3 AVEK4 66 74.57.47 RF S/V SPECIMEN 334 3434 9 3 り ら 10% 4 e 8 e8 4 4 4 SECT 10N SECTION SECTIM SECTIN SECTION MMEADIATELY 1 : . 5 1 505 را (را (3)END 1 DE011CED REDUKED RED CED (3) EN 1760yC60 REDUCE D 9 : : : 1 ; ÷ W MACUDED COMPRESSOMETE EXTENSOMETER 3.60 2.75 4.09 11/2 3.98 2.27 3.29 3.39 9; 63 2.54 3.47 3.50 6.51 3.49 DIRECTION 3.31 Š 14.7 4:// 4110 32.0 31.6 48.0 30.0 36.0 53.6 42.4 42.2 HPS. 40.6 53.8 50.6 0 47.7 3 (45%) 3/. 43. 45. 31. 11. 47. 101 WARD 30 FOR MEASURENENT 4 VALUE AND PC-7M B-3M NATER 1110 16 A F Ó 4040 STR. 4 (2) WET BULMS WISKILED ŝ ゲルイフ MITH 2/42 Comp TEMP. BETWEEN Ų į 5/2015 (1) ANSLE LOZONG. (DESPECS) TONUALE ULTIMATE TABULATION SHEET 1 3, 0 1.P406 20401 0110 A1166E SOUKED 476.8A66 106-10-2 0 m 4VEX466 AVERAGE E- 8-01 2-4-7 106-8-2 8-7-60 1758464 1 1 1-81-10 110-8-107-6-1 106.0. -8-60 101-19-107-A-110-1 3 1-601 an \mathcal{I} V 60.00 7) Ĉ,

TABLE III CONTD. COMPRESSION TESTS

Page 44 FGT-2186 MEASURENENT ST84 12 AND RES/1 4 200 444 28 28 WW 4944 316 MUMU SECTION SECTION SECTIVI SECTION (205) ` 3 : • * : (3)END (3)END (3)END an=(E) REDUCED REDUCED BEDILED FEDUCED! • • LOCAT 1 : 1 B : : * 3.60 3.79 3.10 2.85 2.99 3.21 3.75 2.49 2.89 2.51 3.99 2.93 8.03 2.59 3.42 3.29 150, 3.47 <u>is</u> ! 28.6 23,5 25.0 37.8 39.9 36.3 25.2 39.5 21.0 WITH COMP 26.8 91.9 26.1 1.15 39. 25. 42. 45. BOOK 42077 4 1 F 1710 47 1/2 200 SOAKED (Z)WET 401 かパ 300 TEMP F (DEGREES) 1) 11/61 E 20 20 20 20 20 TABULATION SHEET 90 9 15 0 E-8-801 107-6-3 108-0-4 8-2-01 8 8-7-90, 4VERAGE 4VERAGE AVERAGE 108-8-3 4-0-80 110-4-3 106-8-4 106-13-3 6-8-10 6-2-20 4-4-90 4-6-60 107-8-3 AVERAGE 10-6-2 AVERAGE C-2-90, 1-2-801 S.PECINIEN

CONVAIR—FORT WORTH
TABULATION SHEET

ABLE III CONTO. COMPRESSION TESTS

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WITH CEAS.	, I	$ \cdot $	81.4 7.	7 3.06	24.5 2.75	1 3.00	90	┼	3 3.07	1.57	1.0	9.7 1.69	20.7 1.64	30		30.3	32.2 3.08	α	 3.30	/	4.4 3.04	36.2 3.17		3.31		33.6 3,31						-	
CLOTH 1	171000 1151	*>	300 €	200	28	e.g	20		31.	61		78	\\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\	e.	29.	3	3	3	300F FOR	WHILE STRESSED 3		STR VAUE 3	 300F FOR K		OF ROOM TEMP 3	STR. VALUE 3							
181	0700		SOAKED AT	50K 100												\			SOAKED AT	- 1	TO 20% OF	# P.	SOAKED AT	Mes.	To 10/2 OF	ULT COMP			-				
HEET	(1) ANSLE TEST LOADING TEMP.	(DECRECS) (F)	0 300		~				45		->			36		À			0	-			0		A	x							
TABULATION SHEET	Sticker en no.		106-4-5	107-4-5	108-4-5	110-8-4	AVERAGE		106-8-5	107-8-4	108-8-4	110-8-4	AVERAGE	`,	J	5-5-801	110-0-8	AVERAGE	106-4-6	1	110-4-5	AVERAGE	106-4-1	1	, ,	AVERAGE							

TABLE III CONTD. COMPRESSION TESTS

MEDICAEMENT Page 46 |**FGT_T2**]86 ST8.NV 6 5/5 Section SECTION SECTION ; ; ; LOCATION FAILURE • 2 ; ; : `. がどのおけ REDUCES 5.501037 ; . * • 2.20 2.62 2.34 2.85 9.35 3.43 3.16 3.01 30 3.77 WITH ULTIMATE SOMP STIC. 28.4 33.3 30.1 (KS1) 30.9 17.6 18.3 39.4 34.6 17.7 33.6 8 1 500E CC 07H ė CONDITION 47 /a SOAKED rok 500 DANGLE TEST U (DEGREES) 90 TABULATION SHEET 45 4VERAGE 106-8.5 107-13-5 108-15-5 110. 4VEX116 5-2-01 110-8-5 5-2-90, 2-2-60 414446 C-1-801 110-1-7 6-7-20 106-4-7 SPECIMEN

TABLE IN COMPRESSION TESTS

Page 47 FGT_T2186 MEDSUKENENT TEMPERATURE STRAIN ROOM 4110 4VERA66 4554 J 108/08/08/08 4944 4444 E8 E8 18 18 F, 7657ED A 3015 43276 SECTIM SECTIM SECTIM SecTIM (* C) : ? : ? : ` CRE SPECIME コランバニラグ 100A D/770 C73/032 REDICED 1 REDUCED DITTO IMM & DIATEL . : COMPRESSOMETER INCLUDED 3.72 3.25 2.84 4.27 62 49 1.47 1.45 2.73 EXTENSOMETE 3.48 3.14 10. 3.16 150 6,0 106 3.15 Ų AND 30.5 47.4 28.0 62,3 46.3 52.4 26.2 0 56.5 54.0 47.9 ¥ 50.2 11/1 ž 45.6 DIRECTION OR 3 HES. 500 45. 54. 39. رم در 25. TVDE イイのアグ 30 WARP TER F MEASUREMENT VALUE ×-311 PC-70 1/1 7 837 9 AND (2) WET 0 57 E. WITH 11/1/2 DISTILLED BU14 467 TEALP. (F) 1657 comp. STRAW (1) ANSLE BETWEEN (2) SOAKED IN BOILINS (DEGREES) 10407 WANGLE. CONVAIR 45 TABULATION SHEET 06 040 3) ULTIMATE AND ノバメダイ 5 112-8-1 **ダンぎんなら ド** 112-4-6 4VERASE 115.816E 111-4-2 7-17-1 1-8-61 ノーソーバ 1-2-2/ 13-(-1 1-0-6/ NW Ď 3515 12-4-1 111-1-ダース SPECINIEN

CONVAIR—FORT WORTH
TABULATION SHEET

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TABLE IL CONTD, COMPRESSIN TESTS

Page 48 FGT-2186 イヤックシアドグラグト STRAW PESIN 440 めら 2121V1V1V NNNN mm VV (00%) REDUCED SECTION
REDUCED SECTION REDUCED SECTION SECT10# SECTION REDUCED SECTION SET10N DITTO ABOUE ABOUE ABOVE : ! LOCATION FAILUPE 2.91 " " 2.75 REDICED 5 2.62 (3) END (3)END 2.32 (3)END 3.03 REDUCED REDIKED ₹ 1 DITTO DITTO ; ; 55877 2.66 1.34 2.96 2.93 23 ,05 2,72 25 2.39 2.96 1.47 ٠. س KIIN 52.6 43.0 COMPESTE 48.9 26.2 26.6 28.3 26.4 (KSI) 21.1 24. 4 5.2.8 14.0 5110 47.2 000 7 13.8 19.1 220, 3 C1071 300E 9 1110 47 4 SOAKED 000 (2) WE. Pop (1) ANGLE TEST LOADING TEMP 300 DEGREES) 2 45 54 0 113-8-3 114-8-3 AVERAGE ///- (-3 ///2-(-3 //3-(-3 5 112-4-3 4VERAGE WERAGE 12-8-3 MVER4GE 4VEK16E 11-4-3 11-8-3 113-8-2 114-8-2 112-6-2 113-6-2 1-2-41 111-13-2 111-0-2 SPECIMEN

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N 7857	N	200		9						11/02 11V	ABOUE	A 1301E	A BOVE			SECTION!	**	*	Section			SPECIMEN	SECTION	`		SECTION	:	"	,,										
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	1	201	(154)	1.95	2.46	1.90	2.04	2.09					-	***************************************		2.72	2.40	2.88	2.34	2.84		BEFORE	2.63	2.58		2.80	2.77	2.85	******************************	2.81									
con To.	H WI	ULTIMATE COMP STR.	(KSV)	15.9	13.4	14.3	17.6			14.7	6.9		13.9	11.7		26.1	23.1	35. F	15.8	25.2		541	23.3	26.		- }		30.0	22.6	26.6									
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CONVAIR—FORT WORTH
TABULATION SHEET

TABLE I CONPRESSION TESTS

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SPECIMEN NO.	() ANGLE	TEST TEMP.	cono	171	50	COM PS	106	FAILURE	200	JIG 4ND	STEAN	MEASU	MEASUREMENT
	(DEGREES)	(3)				(1521)							
116-4-1	0	R. T.				53.6	3.75	REDUCED	SECTIM	7			
117-4-1						5.24	4.66	//	"	2			
118-4-1	>					47.4	4.55	~	,	4			
119-4-1						41.9	4.75	**	<i>"</i>				
AVERAGE						47.6	4.43						
11/-18-1	27					23.6	1.09	Repuxes	46(T)34	n	+		
117-13-1						20.0	6.	1		28			
118-8-1	>					23.9	1.40		1,	4			
1-8-611				-		22,6	5/1	"	*/	/			į
AVERAGE	-					22.7	1.09						
												-	
1-2-9//	06					31.8	.76	REDUCED	SECTION	J			
117-6-1		-				19.2	580	"	•	4		-	
ıl٧	>	>				91.2	.73	*	1	ч			
119-611						21.6	. 1	;	;				
AVERAGE						31.0	78						
116-4-2	0	300	SOAKED	47	300E	31.0	3.15	REDUCED	SECTION.	7			
117-4-2			FOR ,	00,	Wes.	34.7		QN3(2)	S				
118-4-2	;	>				30.2	3.40	ZEDUKED	SECTION	7			
119-4-3						40,7	İ	*	//				
DUEPAGE	-					34.0	3.57						
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(2) - ULTIM	1	comp	STR	. VAG	シシ	Nor	INCLU	1050	3	AVERA	シシ		

TABLE I CONTD. COMPRESSION TESTS

	MEASY RENEW T															- 1												Pa	ge T-	21	86			
DESIN	AND STEAM								4	2	4																							
(45.54) PES	516		SECTION 2		18	SECTION 3			SECTION	``	. 0	, ,			SECTION 3	3	3	5		Section 3	, ,	100			 	 	-				-		-	
CLASS II	LOCATION		REDUCED SA	//	(Z) END	REDUCES SE		- 1	REDUCED :	``	ì	1			REDUCED SE	//		:		REDUCED S	`	1												
7.	Ec. 2		.85 PR		188		.85	+	\dashv	.77	46.		.80	_		4.64	3.98	3.58	4.05		4.25	3.80	4.32								ļ			
TIM H	ULTIMATE COMPO. ST.R.	(152)	15.6	16.3	18.8		0.91			14.5	15.0	14.9	14.6		37.8	33.9	1	l	35.3	41.0		['	96.9											
C407.	201		3005	N											3005	MIKE	% of Room	8	<u> </u>	300 E	. WHILE	40% OF POST	a.											
143	CONDIT		KED AT	001							/				SOAKED AT	4	160 TO 20%	000		SOAKED AT	DO HRS.	CSS 60 70	17.7						-		-			
	7EST 7EMP.	E	300 500												Pas	FOR	0353815	TEMP		808	207	V	TEMP										-	
SHEET	()ANSLE 7		L	-	-3				90		>				0		>			0			-											
TABULATION SHEET	100		8-2	17-8-2	1-8-2	18-2	AVERAGE	į	16-5-2	17-6-3	C-5	6-0	VERAGE		A-3	4-3	d		16E	1-4	7.2	2-2	AVERAGE											
TABUL	SPECIMEN		8-9//	117-1	-111	119.	DVEK		-9//	117-	-811	-611	AVEX		116-4-	7-211	'I '	119-	AVERAGE	116-14-4	4-711	1	41/6											

TABLE I CONTD. COMMESSION TESTS

Page 53 FGT-2186 MEASYKEMEN STRAIN 4.5 3/6 (4232) SECTION . 71 REDUCED SECTION .63 REDUCED SECTION : 7 : • 1 ; LOCATION FAILURE PEDWED : ` ; : : : 69. .68 3.93 3.94 1200 WITH 25.2 22.6 0.0 9 (152) 9.5 12.12 Ġ 500E CLOT CONDITION SOAKED FOR DANGLE TEST. 200 (DEGREES) TABULATION SHEET 8 0 117-6-3 //6-8-3 //7-8-3 //8-8-3 //9-8-3 40. 4VERAGE 4VERAGE AVERAGE 16-0-3 7-4-5 18-4-5 2-4-61 16-4-5 SPECIMEN

Page 54 FGT-2186 MEASUREMENT 5TR411 470 (506) SPECIMEN 316 ed 28 el el elala 18 18 18 444 SECTION SKTOW TEST SECTION SECTION SECTION > : : LOCATION FASCURE 5.35 REDUCTO 5 4.12 (2) END 4.32 REDKED SE END (DEND (2)END 2.06 REDUCED 4.90 (2)ENZ 6.33 REDUCED REDUKED COMPRESSOMETER EXTENSOMETER > ? 11 1 7 COMPRESSION MCCUBED DIRECTION 2.35 4.64 5.43 2.03 5.0% 5.43 2.03 2.21 2.17 2.19 (154 30 53.3 65.4 22.9 0,46 27.9 26.0 75.2 26.5 26.2 22.7 63.4 20.8 イベン 7476 107 1 MEASUREMENT AND WARP K 300/ 0 A 90 180 DC-7M B-3M TEAF 7413LE CONOIT S 43 SOAKED SYR. 40AD WITH WITH 80167 FOR STRAIN # BETWEEN 300 TEMP B-9070 P406-B resi T CONVAIR WANGLE LESTONC (DEGREES) TABULATION SHEET 4110 25 8 CONVAIR — FORT WORTH 0 0 ANGLE 1771 ١ ١ 122-4-2 121-B-1 122-B-1 123-B-1 124-B-1 AVERAGE 24-4-3 4VERAGE 21-4-3 AVERAGE 80. 21-6-3 1-2-20 123-6-1 AVERAGE 123-6-D -4-12 122-A-123-4--W-421. N 1 SPECIMEN

TABLE ILL CONTO. COMPRESSION TESTS

Page 55 FGT-2186 MEASURENINT 11/48/12 カグロ 716 4/4 (506) 4 58(11:11) SECTION 4.99 REDUCED SECTION 4.90 SECTION SECTION SECTION EASCURE K 1 ; : • > (2)END (2)END 1.57 (EDUCE) S 1.90 "... 1.27 "... 1.72 "... 5.49 REDIKED 5.37 " 3.74 (2)EN L 1.85 REDUCED EEDUKED. REDUCED : = : ٤. : 2.44 2,04 1.85 1.59 2.43 1.78 6: 1.9 30.3 43.0 30.3 35.7 22.6 14.3 23.0 18.0 0.8 COMP 15.9 15.4 (ESI) *\i* 3 CLOTH 300E 500F HES 9 Ž 47 CONDITI 77 43 100 SOAKED SOAKED FOR 60,0 TEST TEMP 300 500 (1) AN 616 LOADING (DECREES) TABULATION SHEET 45 90 90 0 500 121-8-2 122-8-2 123-8-2 124-8-2 121-C-5 122-C-2 123-C-3 121-A-5 122-A-3 123-A-5 124-A-7 121-6-3 124-C-3 AVERAGE 123-13-3 AVERAGE 123-6-5 4-7-421 AVERAGE AVERAGE 122-18-5 AVERAGE 21-8-3 SPECIMEN

ントンシイ COMMESSION 7481E VII

Page 56 FGT-2186 AND STRAIN MEASURENENT SPECIMEN (858) 9 ω 35 mm www. WW. SECTION SECTION SECTION ; 00 1 1 130A7131 1 > ; 1 COMPRESSOMETER 4.23 ". 4.23 ". 3.90 ". 2.49 REDUCED 1.33 REDIKED 1.47 REDUCED (×) EXTEN SOMETE DIRECTION 1 * 0000 3.98 4.08 3 2.80 1.27 1.39 43 7 1.46 1.51 7 24.7 25.2 59.5 23.9 23.2 69.6 25.0 25.4 27.2 25.5 16.7 MEACUREMEN 16.2 17.3 MARP i 3005 3/1 CONDITION 020 CEA, A 9 ∞ 43 6040 SOAKED WITH エイノス V BUILT メノダ Ó BETWEEN STR P406-13 TEMP 1. 0 300 CONVAIR E 244/24 E DEGREES DND TABULATION SHEET 15 06 CONVAIR — FORT WORTH 0 AN66 10 129-4-2 AVERAGE 5 AVERAGE 4VERAGE 128-4-2 128-4-1 127-8-1 128-8-1 J/6 21-4-2 126-6-1 129-8-26-18-1 1-2-621 4VERAGE 126-4-126-4-127-14. 3 SPECIMEN

アディアス COMPRESSION CONTO. 7486 VIL

Page 57 FGT-2186 MEASUREMENT STRAIN RESIM 42.0 828) $\omega^{\omega}\omega\omega$ m m m から 480VE .50 DELAMINATION IN PELAMINATION IN DITTO ABOVE - DITTO ABOVE 480VE ABOVE 400 2 JE FAILURE 2,770 .50 DITTO 37 01770 19 (SE) 52 10,000 (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) (M. 10) 3 6.0 201 62074 47 300F CONDITION 43 1/4 SOAKED Pop TEST TEMP, 300 1)ANGLE DESREES) 00 TABULATION SHEET 126-C-2 127-C-2 128-C-2 129-C-2 126-B-2 127-B-2 129-B-2 129-B-2 10 AVERAGE SPECIMEN

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